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General Article

Spider diversity (Arachnida: Araneae) in Atlantic Forest areas at Pedra Branca State Park, Rio de Janeiro, Brazil

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Abstract

Background

There has never been any published work about the diversity of spiders in the city of Rio de Janeiro using analytical tools to measure diversity. The only available records for spider communities in nearby areas indicate 308 species in the National Park of Tijuca and 159 species in Marapendi Municipal Park. These numbers are based on a rapid survey and on an one-year survey respectively.

New information

This study provides a more thorough understanding of how the spider species are distributed at Pedra Branca State Park. We report a total of 14,626 spider specimens recorded from this park, representing 49 families and 373 species or morphospecies, including at least 73 undescribed species. Also, the distribution range of 45 species was expanded, and species accumulation curves estimate that there is a minimum of 388

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(Bootstrap) and a maximum of 468 species (Jackknife2) for the sampled areas. These estimates indicates that the spider diversity may be higher than observed.

Keywords

Survey, faunistics, Neotropics, South America

Introduction

The Atlantic Forest is one of the largest centers of biodiversity in the world (Myers et al. 2000). Its original area covered around 15% of the Brazilian territory, from the state of Rio Grande do Sul to the state of Piauí, and also portions of Paraguay and Argentina. However, only around 8% of its original cover remains preserved (Fundação SOS Mata Atlântica / Instituto Nacional de Pesquisas Espaciais 2011). Many of the remaining fragments are under intense anthropic pressure and are unevenly distributed throughout the biome, which hinders the preservation of endemic and threatened species (MMA: Ministério do Meio Ambiente 2012).

A large portion of Rio de Janeiro city is covered by remnants of the Atlantic Forest, distributed on three large mountain ranges: Gericinó-Mendanha to the north, Tijuca to the southeast, and Pedra Branca to the southwest. The latter includes the Pedra Branca State Park, or Parque Estadual da Pedra Branca (ICMBIO 2008).

Despite considerable abundance in the Atlantic Forest, arthropod communities in the area are still poorly known. Terrestrial arthropods represent the largest proportion of the known biotic diversity in the world, where many highly diverse arthropod taxa are excellent bioindicators, even at small scale (Andersen 1990, Schowalter 1995, Brown 1997, Fisher 2000, Ferrier et al. 2004).

Spiders (Araneae) and other arachnids present high diversity, high abundance, and variable life styles. They are one of the main predators in terrestrial environments with a considerable impact upon prey population, acting as agents of biological control (Nyffeler and Benz 1987, Riechert and Lockley 1984, Young and Edwards 1990). Spiders, in particular, are highly diverse, with more than 45,000 species in 114 families (World Spider Catalog 2015). According to Agnarsson et al. (2013), around 50 % of the deposited material in collections around the planet is composed by undescribed species. Some estimates point out that more than 80,000 species of spiders still await description (Brescovit 1999).

Spiders are a choice group for the carrying out species surveys with standardized techniques, because they are abundant and easily found (Coddington et al. 1991, Cardoso et al. 2008). Fieldwork may then be composed by active and passive sampling techniques during specific unit of time, allowing for the comparison of species diversity and study of the structure of the community of spiders (Coddington et al. 1991, Scharff et al. 2003).

Neotropical spider fauna seems to be the least known among the high diversity areas around the globe. One example of our incipient knowledge is the citation in Brescovit et al. (2011) of only 3,203 spider species for Brazil, included in 72 of the 112 known families at that time. However, this number is clearly underestimated, as the real diversity surely is much higher. Until now, there are records about the richness of species of spiders for some Brazilian states, like Amazonas (e.g. Nogueira et al. 2014), Bahia (e. g. Melo et al. 2014), Mato Grosso (e.g. Raizer et al. 2005), São Paulo (e. g. Candiani et al. 2005, Indicatti et al. 2005, Brescovit et al. 2011) and Rio Grande do Sul (e. g. Buckup et al. 2010). Additionally, there is a recent book chapter about the spider fauna of Parque Municipal do Marapendi in the city of Rio de Janeiro (Baptista et al. 2015) and other unpublished data (Santos et al. 2009).

According to Brescovit et al. (2011), the known spider fauna for São Paulo state is represented by 875 described species, in 50 families. There are also records of 808 described species in 51 families for Rio Grande do Sul (Buckup et al. 2010). In comparison, our knowledge on the Rio de Janeiro spider fauna includes 953 described species, as well as roughly 287 undescribed species and 258 morphospecies. According to the monograph of Quintarelli (2014) and a database compiled by R. Baptista (UFRJ) and partners, there are 1,498 species or morphospecies recorded for Rio de Janeiro in 61 families. Despite its small area, the spider fauna from Rio de Janeiro is the most diverse and best known in comparison to other states in Brazil according to available data. However, the current species list for Rio de Janeiro is still limited, incomplete and has never been published.

This paper presents a standardized survey of the spider fauna and statistical estimates of the diversity in four forested areas at Pedra Branca State Park, the largest urban forest of Rio de Janeiro city. Previously, there were only records of sporadic fieldwork and rare citations in the literature about the spiders from the park, including type material of two species and specimens belonging to only 26 additional species or morphospecies.

Material and methods

Study Area

The Pedra Branca range is located at the municipality of Rio de Janeiro, between 22º 55' - 23º 05' S and 43º 20' - 43º 40' W (Figs 1, 2). It has 197.27 Km² of area, aproximately 12,500 ha. The area of the park includes all slopes above 100 meters and forested areas nearby, surrounded by plain areas already occupied by urban sprawl (Coura et al. 2009). It is estimated that 6,920 ha (55% of the area) is covered by well-preserved forest and that 3,216 ha (26%) is under strong anthropic pressure, now covered by regenerating forests and grass fields. The Pedra Branca State Park was created in 1974 in order to protect the remaining natural environment, and especially the hydrographic network (Coura et al. 2009).

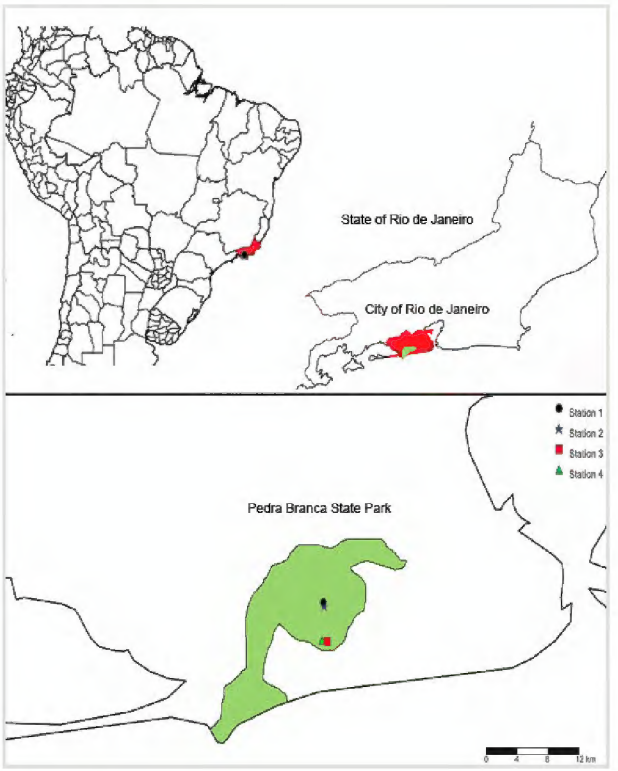

Figure 1.

Collection stations in Pedra Branca State Park.

Figure 2.

Pedra Branca State Park on Google Earth. Circle: Station 1; Star: Station 2; Square: Station 3 and Triangle: Station 4.

Four work stations were chosen for the present study. Each one is considered as the center of a square of 100 m^2, in which the spiders were collected. In the park, there are only three access points, consisting therefore of three core stations. One of them is distant and the area is covered by recent vegetation (Piraquara core) whereas the other two (Pau-da-Fome and Camorim cores) have trails penetrating a more protected, older forest. Thus, two work stations were located near Pau-da-Fome (the main core station of the park) and two nearby the Camorim accessory core. The stations were chosen due to their

preservation state and security reasons. One station in each access point was chosen in the best preserved areas we could find. The other stations were chosen near heavily used trails and considered as under higher anthropic effect with clear evidence of recent succession. The stations are:

Station 1 (S1): Pau-da-Fome – Figueira (anthropic)

Station 1 is located at an area of trails nearby the headquarters of Pau-da-Fome core station and the river that crosses the region. This area is subjected to a high influx of park visitors due to its easy access and use of the river for recreation. Here, the trees are smaller and more widely spaced with high abundance of bushes, soil bromeliads and exotic plants, as the big fig tree after which the trail is named.

Location: 22° 55' 57.0" S and 043° 26' 32.3" W. Elevation: 138 m.

Station 2 (S2): Pau-da-Fome – Padaria

Station 2 was initially considered by us as one of the oldest forest areas at Pau-da-Fome. It is reached after a 20 minute walk in a secondary trail following one of the park streams. This area is not easily accessed by the public and comprises the ruins of an old farm from the 19th century, which is surrounded by moderately steep ravines. There are few exotic plants and bushes at this station, with a clearing in the ruins, where there are small trees and some bushes and herbs, alongside moderately closed canopy in the surroundings. The stream borders were covered by more bushes and herbs than the remaining points.

Location: 22° 56' 12.8" S and 043° 26' 29.1" W. Elevation: 133 m.

Station 3 (S3): Camorim – Sede (anthropic)

This station is located just behind the accessory core of Camorim. This area is under high pressure due to the park facilities and the constant human activity for recreation and water use. Also, there is a dam in the Camorim river and equipment for collection and treatment of water for human consumption on the nearby areas of Rio de Janeiro city. The trees are smaller than in other stations and there is a large number of bushes and exotic trees. All the spider collections were done alongside the river banks and on the nearby ravines.

Location: 22° 58' 12.0" S and 043° 26' 16.4" W. Elevation: 160 m.

Station 4 (S4): Camorim – Açude

This station is reached after a 45 minute walk in a steep trail that leads to a relatively large dike built for water collection. It is considered the best preserved area in this work. A larger number of higher trees and a denser canopy is found at this station, coupled with a small number of bushes and herbs, which indicate an older forest tract. There is no water course in the vicinity, but the river is located around 200 m from the station center, at the bottom of steep ravines.

Location: 22° 58' 08.3" S and 043° 26' 38.5" W. Elevation: 342 m.

Collection Techniques and Identification of Specimens

Spiders were collected using methods adapted from the ones broadly used in similar studies (e. g. Coddington et al. 1991, Toti et al. 2000, Soerensen et al. 2002, Scharff et al. 2003, Cardoso et al. 2008). All active searching samples took 30 minutes each. The first method is called “looking up”, where all spiders seen from the knee to the highest point the researcher can reach were collected. This technique was done with one sample during the day (from 08:00 to 12:00) or in the afternoon (13:00 to 18:00), depending on field conditions, and two samples of 30 minutes each during the night (from 20:00 to 23:00). The second method called “looking down” aims to collect spiders found from the height of the knee to the ground. As in the previous technique, only one sample was done during the day, whereas two samples were made during the night. “Looking up” and “looking down” were the only active techniques used during nocturnal sampling. The third technique is called “sweeping”, where an entomologic net (diameter approximatelly 40 cm) was moved over herbs and bushes to collect spiders, up to the level of the researcher's knee. The fourth technique is called “beating”. This method allows the collection of spiders by shaking high vegetation while holding a 1 m^2 tray under it. The fifth technique is called “sieving”, aiming to collect little spiders that live in the litter, by sifting it on a 1 m^2 tray. The sixth technique is called “cryptic”, which is an active method to check on protected and hidden habitats, such as fallen tree trunks, tree and stone cracks and caves, in order to collect spiders that live in such conditions. Besides these active techniques, we used pitfall traps as the only passive technique. Twenty pitfall traps were buried in the ground in each sample station, during 8 days. Each trap was partially filled with supersaturated saline solution. All the spiders collected during this expedition were fixed in ethanol 75%.

The material was sorted into morphospecies at first. In contrast to many published surveys where the juveniles are discarded because they usually do not present many somatic characteristics to place them into morphospecies at species level, most juveniles were taken into account. Juveniles usually represent more than half of all collected specimens and its plain disposal implies in discarding a lot of useful information. The process of identification was conducted by comparison to published papers, type material, whenever possible, and online catalogs (e. g. World Spider Catalog 2015). All identifications were carried out by the authors and voucher specimens are deposited in the collection of the Laboratório de Diversidade de Aracnídeos/UFRJ. The voucher specimens collected during the survey are deposited under sample numbers PBR 001-5,889.

Data Analyses

In this paper, parameters related to alpha diversity were evaluated by estimates of species richness using methods of accumulation curves (Clench equation) and non-parametric estimators: ICE, ACE, Chao1, Chao2, Jackknife 1, Jackknife 2 and Bootstrap. Richness estimates were possible with the use of the software EstimateS Richness Estimator Program, Version 9.1 (Colwell 1999). It generated estimates of species richness based on empirical data.The structure of the communities of spiders was also evaluated with index widely used in taxonomic surveys like: diversity of species with Shannon-Wiener (H’)

Index, equitability with Pielou (J) Index and dominance by Berger-Parker Index (d), calculated by the usual mathematic formulas.

Results

Adding up all information sources, 14,735 spider specimens were recorded for the park, including records from literature, museum collections and our own field collections. Of those records, 14,626 were identified specimens belonging to 373 species and morphospecies in around 220 genera and 49 families. The remaining 109 specimens were early juveniles or too damaged to be identified to the species level.

From the total of 353 species and morphospecies collected in our expeditions to the park, 195 were attributed to species already described (54.9%). Among the others, one genus and 72 species are considered as new to science (20.7%) and 86 were left in the level of morphospecies only (24.4%). The last category includes species represented only by juveniles or belonging to taxa without a proper taxonomic revision. Considering only the 14,492 specimens collected during the survey, 2,754 are males (19.0%) and 4,030 (27.8%) are females, with a total of 6,784 adults (46.8%). The remaining 7,708 (53.2%) are juveniles. Table 1 lists each recorded species, the stations in the park they were collected (S1, S2, S3 and S4), sex (M = male, F = female or J = juveniles) and total abundance (TAb) of specimens.

Table 1.

List of species recorded from Pedra Branca State Park.

Species	**S1**	**S2**	**S3**	**S4**	**M**	**F**	**J**	**TAb**
Amaurobiidae						5		5
Retiro lanceolatus (Vellard, 1924)		X				5		5
Anapidae					2	2		4
Anapis sp. n.		X			2	1		3
Pseudanapis sp. n.			X			1		1
Anyphaenidae					68	79	503	650
Anyphaenoides cf. *clavipes* (Mello-Leitão, 1922)				X			1	1
Arachosia praesignis (Keyserling, 1891)				X	1			1
Aysha affinis (Blackwall, 1862)			X	X		1	19	20
Aysha borgmeyeri (Mello-Leitão, 1926)		X	X	X	6	14	41	61
Iguarima censoria (Keyserling, 1891)				X		1		1
Isigonia sp. n.			X			1		1
Jessica osoriana (Mello-Leitão, 1922)				X		2		2
Osoriella domingos Brescovit, 1998					1			1

Oxysoma sp. 01	X						1	1
Patrera cita (Keyserling, 1891)	X	X	X	X	59	56	373	488
Teudis angusticeps (Keyserling, 1891)					1			1
Teudis atrofasciatus Mello-Leitão, 1929						1		1
Wulfilopsis cf. *frenata* (Keyserling, 1891)	X	X	X	X		1	68	69
Xiruana sp. 01			X			2		2
Araneidae					168	393	1484	2048
Acacesia hamata (Hentz, 1847)						1		1
Acacesia tenella (L. Koch, 1871)	X	X			1	1	2	4
Actinosoma pentacanthum (Walckenaer, 1841)					1			1
Alpaida aff. *morro*	X	X		X		6	7	13
Alpaida alticeps (Keyserling, 1879)		X		X		1	9	10
Alpaida atomaria (Simon, 1895)	X	X	X	X	4	9	15	28
Alpaida tijuca Levi, 1988	X	X	X	X	6	14	76	96
Alpaida truncata (Keyserling, 1865)	X	X	X	X	5	9	48	62
Alpaida venger Castanheira & Baptista, 2015	X		X	X	6	11	36	53
Alpaida sp. n.		X				1		1
Araneus iguacu Levi, 1991	X	X	X	X	5	29	21	55
Araneus lathyrinus (Holmberg, 1875)						1		1
Araneus omnicolor (Keyserling, 1893)	X	X	X	X	1	4	15	20
Araneus stabilis (Keyserling, 1892)	X	X	X	X	1	2	12	15
Araneus tijuca Levi, 1991	X	X	X	X	1	2	14	17
Araneus venator (C. L. Koch, 1838)	X	X	X	X		11	130	141
Araneus sp. 01	X						1	1
Argiope argentata (Fabricius, 1775)								1
Cyclosa caroli (Hentz, 1850)			X	X		2		2
Cyclosa fililineata Hingston, 1932	X	X	X	X	11	62	83	156
Cyclosa morretes Levi, 1999	X	X	X	X	6	14	23	43
Eustala levii Poeta, Marques & Buckup, 2010			X	X	1		2	3
Eustala aff. *levii*	X	X	X	X		1	10	11
Eustala aff. *photographica*	X	X	X	X	3	4	25	32
Eustala sagana (Keyserling, 1893)	X		X			3	12	15
Eustala taquara (Keyserling, 1892)		X				1	1	2
Gasteracantha cancriformis (Linnaeus, 1758)			X	X	1	1	1	3
Kaira altiventer O. Pickard-Cambridge, 1889				X			1	1
Kapogea sp. n.	X				1			1
Mangora aripeba Levi, 2007			X		6	9	3	18

Mangora enseada Levi, 2007			X			2		2
Mangora melanocephala (Taczanowski, 1874)					1	2		3
Mangora missa Levi, 2007	X	X			1	7	15	23
Mangora ramirezi Levi, 2007	X	X	X		4	12	10	26
Metazygia bahia Levi, 1995		X				1		1
Metazygia laticeps (O. Pickard-Cambridge, 1889)			X		1	2	5	8
Metepeira sp. 01				X			1	1
Micrathena annulata Reimoser, 1917	X	X	X	X	13	26	42	81
Micrathena horrida (Taczanowski, 1873)	X		X		2		4	6
Micrathena jundiai Levi, 1985					1			1
Micrathena sanctispiritus Brignoli, 1983	X	X	X	X	46	73	484	603
Ocrepeira gnomo (Mello-Leitão, 1943)		X		X		1	45	46
Parawixia audax (Blackwall, 1863)	X	X	X	X	1	8	32	41
Parawixia monticola (Keyserling, 1892)	X	X	X	X	5	1	15	21
Parawixia velutina (Taczanowski, 1878)			X	X		1	13	14
Pronous tuberculifer Keyserling, 1881		X	X	X	2	3	12	17
Scoloderus cordatus (Taczanowski, 1879)	X	X			4	5	5	14
Taczanowskia striata Keyserling, 1879		X					1	1
Tatepeira itu Levi, 1995				X	2	1		3
Testudinaria sp. n.	X	X	X		1	2	4	7
Verrucosa meridionalis (Keyserling, 1892)	X	X	X	X	1	1	33	37
Wagneriana dimastophora (Mello-Leitão, 1940)	X	X	X	X	13	33	145	191
Wagneriana gavensis (Camargo, 1950)	X	X	X	X	10	13	71	94
Barychelidae					1	1	3	5
Neodiplothele fluminensis Mello-Leitão, 1924				X		1	3	4
Paracenobiobelma sp. 01		X			1			1
Caponiidae					3	3	2	8
Caponina tijuca Platnick, 1994		X			2	2	1	5
Nops sp. n.		X		X	1	1	1	3
Clubionidae					2	5	7	14
Clubionidae sp. 01	X	X	X	X	2	5	7	14
Corinnidae					84	42	135	261
Castianeira brevis Keyserling, 1891								
Castianeira sp. 01	X	X			1	1		2
Castianeira sp. 02		X	X	X			4	4
Corinna aff. *capito*			X	X	3	1		4
Corinna demersa Rodrigues & Bonaldo, 2014						2		2

Corinna inermis (Bertkau, 1880)				X	1	1		2
Corinna aff. *mourai*				X	1	2	1	4
Corinna nitens (Keyserling, 1891)		X	X	X	4		12	16
Corinna sp. 01	X	X	X	X	1		5	6
Corinna sp. 02			X				1	1
Corinna sp. 03	X			X			2	2
Creugas sp. 01	X	X	X	X	14	9	23	46
Creugas sp. 02	X	X	X	X	34	14	11	59
Ianduba varia (Keyserling, 1891)	X		X	X	12	7	13	32
Myrmecium obscurum Keyserling, 1891			X	X	2		9	11
Myrmecium rufum Latreille, 1824			X	X	7	3	43	53
Paradiestus sp. 01				X			1	1
Stethorrhagus sp. n.			X			1		1
Tupirinna sp. n.		X	X	X	3		7	10
Xeropigo tridentiger (O. Pickard-Cambridge, 1869)					1			1
Xeropigo sp. n.				X		1		1
Ctenidae					81	66	343	490
Ctenus medius Keyserling, 1891	X	X	X	X	1	6	81	88
Ctenus ornatus (Keyserling, 1877)	X	X	X	X	8	13	88	109
Ctenus aff. *vehemens*	X	X	X	X	59	44	107	210
Enoploctenus cyclothorax (Bertkau, 1880)		X	X	X	6	2	26	34
Enoploctenus cf. *maculipes* Strand, 1909		X	X	X	2		28	30
Isoctenus griseolus (Mello-Leitão, 1936)	X	X		X	1		13	14
Phoneutria keyserlingi (F. O. Pickard-Cambridge, 1897)		X	X		4	1		5
Deinopidae						5	3	8
Deinopis plurituberculata Mello-Leitão, 1925			X	X		5	3	8
Dipluridae					3	3	6	12
Diplura lineata (Lucas, 1857)				X		1		1
Linothele sp. n.		X	X	X	3	2	6	11
Eutichuridae					5	3	8	16
Radulphius laticeps Keyserling, 1891		X		X	2		1	3
Radulphius sp. n.		X	X	X	2	3	6	11
Strotarchus tropicus (Mello-Leitão, 1917)				X	1		1	2
Gnaphosidae					1	2	6	9
Apodrassodes sp. n.		X				1		1
Poecilochroa cf. *trifasciata* Mello-Leitão, 1918	X						1	1
Xenoplectus sp. n.		X			1	1		2

Zimiromus sp. 01		X		X			5	5
Hahniidae					3	8	1	12
Hahnia sp. 01				X	3	7	1	11
Neohahnia sp. 01			X			1		1
Hersiliidae					4	2	3	9
Ypypuera crucifera (Vellard, 1924)	X		X	X	4	2	3	9
Idiopidae					5		1	6
Idiops camelus (Mello-Leitão, 1937)	X	X			4		1	5
Idiops germaini Simon, 1892		X			1			1
Linyphiidae					118	226	122	466
Dubiaranea cf. *inquilina* (Millidge, 1985)	X	X			11	52	13	76
Erigone autumnalis Emerton, 1882			X			1		1
Exocora phoenix Lemos & Brescovit, 2013	X	X	X	X	9	40	24	73
Laminacauda sp. n.				X		2	1	3
Lygarina sp. n.			X	X	2			2
Meioneta aff. *montivaga*				X	1			1
Meioneta sp. n. 01	X	X	X	X	27	37	27	91
Meioneta sp. n. 02			X		1	1	1	3
Moyosi sp. n.	X	X	X	X	30	33	23	86
Sphecozone rubescens O. Pickard-Cambridge, 1870	X					1		1
Sphecozone sp. n.	X					1	3	4
Vesicapalpus simplex Millidge, 1991	X	X	X	X	30	40	22	92
Erigoninae sp. 01	X		X		7	17	8	32
Erigoninae sp. 02			X			1		1
Liocranidae					12	9	8	29
Liocranidae sp. 01	X	X	X	X	12	9	8	29
Lycosidae						1	1	2
Hogna sp. 01						1	1	2
Mimetidae					44	46	125	215
Gelanor altithorax Keyserling, 1893		X	X	X	4	15	48	67
Gelanor zonatus (C. L. Koch, 1845)		X	X	X	9	8	14	31
Mimetus sp. 01	X	X	X	X	14	7	44	65
Mimetus sp. 02	X	X	X	X	11	9	10	30
Mimetus sp. 03	X	X	X	X	4	5	7	16
Mimetus sp. 04	X				1	1	2	4
Mimetus sp. 05		X			1	1		2
Miturgidae					188	149	129	466

Odo pulcher Keyserling, 1891	X	X	X	X	188	149	129	466
Mysmenidae					10	7	6	23
Maymena sp. n.	X	X	X		2	4	2	8
Mysmena sp. 01	X				1		1	2
Mysmenopsis archeri Platnick & Shadab, 1978	X	X	X		7	3	3	13
Nemesiidae					30	19	31	80
Chaco sp. n. aff.		X		X	3	7	2	12
Gen. n. sp. n.	X	X	X	X	10	2	10	22
Prorachias sp. n.	X				5	1	4	10
Rachias conspersus (Walckenaer, 1837)				X	4	2	5	11
Rachias sp. n.				X	2	1		3
Stenoterommata melloleitaoi Guadanucci & Indicatti, 2004			X	X	2	2		4
Stenoterommata sp. 01		X	X	X	2	4	9	15
Stenoterommata sp. 02		X		X	2		1	3
Nephilidae					2	11	29	42
Nephila clavipes (Linnaeus, 1767)	X	X	X	X	2	11	29	42
Ochyroceratidae					6	71	12	89
Ochyrocera sp. n. 01	X	X	X	X	5	14	6	25
Ochyrocera sp. n. 02				X	1			1
Theotima minutissima (Petrunkevitch, 1929)	X	X	X	X		57	6	63
Oonopidae					48	79	17	144
Brignolia sp. n.	X	X			3	4		7
Neotrops sp. n. 01	X	X	X	X	3	1	2	6
Neotrops sp. n. 02			X	X	3	4	4	11
Neotrops sp. n. 03	X	X	X	X	4	1	1	6
Neoxyphinus keyserlingi (Simon, 1907)	X	X	X	X	5	6	4	15
Orchestina sp. 01				X	1	3	1	5
Triaeris stenaspis Simon, 1891		X	X	X		5		5
Gamasomorphinae sp. 01	X	X	X	X	19	38		57
Gamasomorphinae sp. 02		X				1		1
Oonopinae sp. 01	X	X	X	X	10	14	4	28
Oonopinae sp. 02				X		1		1
Oonopinae sp. 03				X			1	1
Oonopinae sp. 04			X			1		1
Oxyopidae					1	2	3	6
Oxyopes cf. *rubrosignatus* Keyserling, 1891	X						1	1
Peucetia flava Keyserling, 1877						1		1

Peucetia rubrolineata Keyserling, 1877						1		1
Schaenicoscelis elegans Simon, 1898	X				1		2	3
Palpimanidae					4	5	7	16
Fernandezina tijuca Ramírez & Grismado, 1996	X	X	X	X	1	3	7	11
Otiothops sp. n.				X	3	2		5
Philodromidae							6	6
Berlandiella cf. *insignis* Mello-Leitão, 1929				X			6	6
Pholcidae					932	1112	1776	3820
Carapoia sp. n. 01	X	X		X	7	2		9
Carapoia sp. n. 02	X	X	X	X	87	132	116	335
Litoporus iguassuensis Mello-Leitão, 1918	X	X			16	36	40	92
Mesabolivar brasiliensis (Moenkhaus, 1898)			X		1	1		2
Mesabolivar cyaneotaeniatus (Keyserling, 1891)	X	X	X	X	20	17	71	108
Mesabolivar difficilis (Mello-Leitão, 1918)	X	X	X	X	18	38	33	89
Mesabolivar luteus (Keyserling, 1891)	X	X	X	X	494	539	1017	2050
Mesabolivar togatus (Keyserling, 1891)	X	X	X	X	143	143	362	648
Mesabolivar sp. n. 01	X	X	X	X	52	50	44	146
Mesabolivar sp. n. 02	X				1			1
Mesabolivar sp. n. 03			X			3	2	5
Metagonia furcata Huber, 2000				X		1		1
Metagonia sp. n. 01	X	X	X	X	32	83	38	153
Metagonia sp. n. 02			X			1	1	2
Metagonia sp. n. 03	X	X	X		37	41	30	108
Metagonia sp. n. 04				X	3	2		5
Tupigea sp. n. 01	X	X	X	X	21	23	22	66
Pisauridae					6	10	40	56
Architis brasiliensis (Mello-Leitão, 1940)				X	6	10	40	56
Prodidomidae						1		1
Lygromma sp. n. 01				X		1		1
Salticidae					121	125	399	645
Acragas sp. n.	X					1		1
Arnoliseus sp. n. 01		X	X	X	3	2		5
Arnoliseus sp. n. 02	X	X	X	X	18	14	23	55
Beata aff. *zeteki*		X				1		1
Breda cf. *milvina* (C. L. Koch, 1846)	X			X			2	2
Chira lucina Simon, 1902		X	X		1	1	2	4
Chira thysbe Simon, 1902		X	X			1	1	2

Chirothecia aff. *semiornata*		X			1			1
Coryphasia albibarbis Simon, 1902	X	X	X	X	14	3	124	141
Coryphasia aff. *albibarbis*			X			2		2
Corythalia sp. 01		X	X			1	3	4
Cotinusa magna (Peckham & Peckham, 1894)	X	X	X	X	3	4	25	32
Cylistella cuprea (Simon, 1864)		X	X	X	4	1		5
Dendryphantes sp. 01						1		1
Encolpius guaraniticus Galiano, 1968		X			1	3	1	5
Erica eugenia Peckham & Peckham, 1892	X	X	X	X	4	3	34	41
Euophrys sp. 01	X	X			2	1		3
Freya sp. n.			X		1			1
Itata sp. n.	X		X		1	1	4	6
Lyssomanes austerus Peckham, Peckham & Wheeler, 1889	X	X	X		3	3	10	16
Mago aff. *longidens*		X	X		2			2
Mopiopia bruneti Simon, 1903	X		X	X	1	2	5	8
Mopiopia gounellei Simon, 1902	X	X	X	X	2	3	10	15
Mopiopia sp. 01	X	X			1	3	3	7
Noegus bidens Simon, 1900	X	X	X	X	6	1	18	25
Noegus comatulus Simon, 1900	X	X	X	X	22	35	81	138
Phiale mimica (C. L. Koch, 1846)			X			1	1	2
Pseudofluda cf. *pulcherrima* Mello-Leitão, 1928				X		1		1
Romitia sp. 01		X					1	1
Semnolius sp. n.		X	X		1	1	6	8
Semnolius sp. 01	X	X	X	X	5	9	9	23
Tacuna aff. *vaga*	X	X		X	1	2	2	5
Tariona aff. *mutica*	X	X	X		2		7	9
Thiodina sp. n.			X			1		1
Vinnius uncatus Simon, 1902		X		X		1	2	3
Euophryinae sp. 01	X	X	X		1	2	2	5
Salticidae sp. 01	X		X		2	1	2	5
Salticidae sp. 02	X	X				1	2	3
Salticidae sp. 03	X	X		X	3	9	3	15
Salticidae sp. 04			X	X	10	1	11	22
Salticidae sp. 05	X			X	2	1		3
Salticidae sp. 06				X		2		2
Salticidae sp. 07			X	X		1	3	4
Salticidae sp. 08		X		X	1	1		2

Salticidae sp. 09				X		1		1
Salticidae sp. 10			X		3	2	2	7
Scytodidae					6	4	18	28
Scytodes itapevi Brescovit & Rheims, 2000		X	X	X	2		2	4
Scytodes aff. *lineatipes*	X	X	X	X	4	4	16	24
Segestriidae						2	2	4
Ariadna cf. *obscura* (Blackwall, 1858)			X	X		2	1	3
Ariadna sp. 01		X					1	1
Selenopidae					1	1		2
Selenops melanurus Mello-Leitão, 1923			X		1	1		2
Senoculidae							3	3
Senoculus iricolor (Simon, 1880)		X					1	1
Senoculus sp. 01				X			2	2
Sicariidae					6	13	16	35
Loxosceles adelaida Gertsch, 1967		X			6	13	16	35
Sparassidae					15	14	102	131
Caayguara albus (Mello-Leitão, 1918)		X		X	1		1	2
Caayguara cupepemassu Rheims, 2010					1			1
Caayguara cupepemayri Rheims, 2010		X	X	X	1	1	4	6
Caayguara pinda Rheims, 2010	X	X	X	X	12	12	95	119
Polybetes rapidus (Keyserling, 1880)	X			X		1	1	2
Stasina americana Simon, 1887		X					1	1
Synotaxidae					1	1	8	10
Synotaxus longicaudatus (Keyserling, 1891)	X	X	X		1	1	8	10
Tetragnathidae					117	213	495	825
Azilia boudeti Simon, 1895	X	X	X	X	7	20	149	176
Chrysometa boraceia Levi, 1986				X	1			1
Chrysometa ludibunda (Keyserling, 1893)	X	X	X	X	98	157	290	545
Chrysometa sp. n.			X			1		1
Dolichognatha pinheiral Brescovit & Cunha, 2001	X				2		3	5
Leucauge formosa (Blackwall, 1863)			X	X		4	7	11
Leucauge pulcherrima (Keyserling, 1865)			X			12	8	20
Leucauge turbida (Keyserling, 1893)	X		X			5	13	18
Tetragnatha cladognatha Bertkau, 1880			X		5	10	17	32
Tetragnatha mandibulata Walckenaer, 1841					1			1
Tetragnatha sp. 01			X		1	1		2
Metinae sp. 01	X			X	2	3	8	13

Theraphosidae					7	9	6	22
Catumiri sp. 01		X		X		2	3	5
Eupalaestrus spinosissimus Mello-Leitão, 1923			X			1		1
Homoeomma familiare Bertkau, 1880			X	X	1	1	1	3
Lasiodora fallax (Bertkau, 1880)				X		1		1
Magulla buecherli Indicatti *et al.*, 2008		X					1	1
Plesiopelma sp. 01		X	X	X	6	4	1	11
Theridiidae					577	1206	1377	3160
Achaearanea tingo Levi, 1963	X					1	2	3
Anelosimus dubiosus (Keyserling, 1891)				X		5	1	6
Anelosimus ethicus (Keyserling, 1884)	X					2		2
Anelosimus studiosus (Hentz, 1850)	X			X		1	1	2
Argyrodes elevatus Taczanowski, 1873	X			X	2	6	2	10
Chrosiothes niteroi Levi, 1964	X	X	X	X	16	31	15	62
Chrosiothes sp. n.		X		X	1	9	8	18
Chrysso compressa (Keyserling, 1884)	X	X	X	X	4	12	85	101
Coleosoma floridanum Banks, 1900			X			1	1	2
Cryptachaea bellula (Keyserling, 1891)	X					1		1
Cryptachaea dea (Buckup & Marques, 2006)	X	X	X	X	18	30	15	63
Cryptachaea digitus (Buckup & Marques, 2006)	X	X	X	X	32	162	385	579
Cryptachaea hirta (Taczanowski, 1873)	X			X	2	3		5
Cryptachaea inops (Levi, 1963)	X	X	X	X	1	8	6	15
Cryptachaea passiva (Keyserling, 1891)	X	X	X	X	8	45	29	82
Cryptachaea aff. *pilaton*			X			1	1	2
Cryptachaea rioensis (Levi, 1963)	X	X	X	X	42	175	32	249
Cryptachaea sicki (Levi, 1963)				X	1			1
Cryptachaea triguttata (Keyserling, 1891)	X	X	X	X	8	26	20	54
Cryptachaea sp. n. 01			X			1		1
Cryptachaea sp. 01				X			1	1
Dipoena bryantae Chickering, 1943			X			1		1
Dipoena cornuta Chickering, 1943	X			X	2	3	3	8
Dipoena aff. *cordiformis*		X			1			1
Dipoena aff. *hortoni*				X		1		1
Dipoena ira Levi, 1963	X	X	X	X	17	14	10	41
Dipoena aff. *kuyuwini*			X	X		2		2
Dipoena militaris Chickering, 1943	X	X	X		2	3	3	8
Dipoena niteroi Levi, 1963	X	X	X	X	23	21	11	55

Dipoena pumicata (Keyserling, 1886)	X	X	X	X	29	17	50	96
Dipoena pusilla (Keyserling, 1886)	X			X	2	2	2	6
Dipoena variabilis Levi, 1963			X	X	1	1	1	3
Dipoena sp. n. 01	X		X		3	1		4
Dipoena sp. n. 02				X		1		1
Dipoena sp. n. 03	X		X	X	1	6		7
Echinotheridion cartum Levi, 1963	X	X	X	X	11	94	93	198
Neopisinus cognatus (O. Pickard-Cambridge, 1893)			X	X	7	7	8	22
Exalbidion sp. n.	X	X	X		7	9	5	21
Faiditus acuminatus (Keyserling, 1891)	X		X		2	4	5	11
Faiditus caudatus (Taczanowski, 1874)	X	X	X	X	15	9	14	38
Faiditus aff. *jamaicensis*			X	X		3		3
Janula bicorniger (Simon, 1894)	X	X	X	X	98	89	137	324
Lasaeola aff. *donaldi*				X	1			1
Neospintharus rioensis (Exline & Levi, 1962)				X	1	1		2
Parasteatoda tepidariora (C. L. Koch, 1841)						1		1
Parasteatoda tesselata (Keyserling, 1884)			X		1			1
Phoroncidia rubromaculata (Keyserling, 1886)				X		3		3
Platnickina mneon (Bösenberg & Strand, 1906)							1	1
Rhomphaea metaltissima Soares & Camargo, 1948	X				2		2	4
Spintharus gracilis Keyserling, 1886	X	X	X	X	6	3	1	10
Stemmops sp. n. 01	X	X	X	X	11	12	3	26
Stemmops sp. n. 02	X	X	X	X	19	35	13	67
Stemmops sp. n. 03				X	1	2	1	4
Styposis sp. n.	X		X		18	22	7	47
Theridion biezankoi Levi, 1963	X	X	X		1	5	9	15
Theridion calcynatum Holmberg, 1876			X		3	3	4	10
Theridion aff. *hispidum*	X				1			1
Theridion teresae Levi, 1963	X	X	X	X	15	29	13	57
Theridion sp. n. 01	X		X	X	16	1		17
Theridion sp. n. 02	X	X	X	X	2	12	6	20
Theridion sp. n. 03			X	X	33	112	43	188
Theridion sp. n. 04	X	X			16	16	9	41
Theridion sp. n. 05	X	X	X	X	7	10		17
Thwaitesia affinis O. Pickard-Cambridge, 1882	X	X	X	X	38	47	301	386
Thymoites sp. n.	X	X	X		26	76	9	111
Tidarren haemorrhoidale (Bertkau, 1880)	X	X	X	X		3	9	12

Wamba crispulus (Simon, 1895)	X				1	5		6
Wirada tijuca Levi, 1967			X	X	2			2
Theridiosomatidae					15	25	13	53
Chthonos tuberosa (Keyserling, 1886)	X	X	X	X	7	10	5	22
Chthonos sp. n.			X	X	3	3	3	9
Theridiosoma sp. n. 01	X	X	X		4	12	2	18
Theridiosoma sp. n. 02	X		X		1		1	2
Theridiosoma sp. n. 03	X						1	1
Wendilgarda cf. *nigra* Keyserling, 1886				X			1	1
Thomisidae					38	24	245	307
Acentroscelus cf. *secundus* Mello-Leitão, 1929		X	X	X	2	5	13	20
Epicadinus gavensis Soares & Soares, 1946	X	X	X		2	1	3	6
Epicadus planus Mello-Leitão, 1932			X				2	2
Misumenops cf. *callinurus* Mello-Leitão, 1929			X			1		1
Onocolus simoni Mello-Leitão, 1915	X	X	X		3		9	12
Strophius nigricans Keyserling, 1880		X				1		1
Tmarus aff. *albolineatus*		X					1	1
Tmarus atypicus Mello-Leitão, 1929		X	X	X		1	2	3
Tmarus sp. n.	X	X		X	4		12	16
Tmarus sp. 01	X	X		X	9	3	49	61
Tmarus sp. 02	X	X	X	X	16	10	120	146
Tmarus sp. 03		X					2	2
Tmarus sp. 04	X	X	X	X	1	2	18	21
Tobias cf. *caudatus* Mello-Leitão, 1929	X		X	X	1		14	15
Trachelidae					9	7	15	31
Trachelas robustus Keyserling, 1891	X	X				2	3	5
Trachelas vitiosus Keyserling, 1891	X	X	X	X	9	5	12	26
Trechaleidae					1	2	34	37
Enna aff. *redundans*	X	X	X	X	1		24	25
Trechalea bucculenta (Simon, 1898)						2		2
Trechaleoides biocellata (Mello-Leitão, 1926)		X	X				10	10
Uloboridae					39	77	187	303
Miagrammopes guttatus Mello-Leitão, 1937	X	X	X	X	13	19	116	148
Philoponella fasciata (Mello-Leitão, 1917)	X	X	X	X	25	55	70	150
Philoponella vittata (Keyserling, 1881)			X			2		2
Uloborus sp. 01	X	X			1	1	1	3
Zodariidae					1	4	7	12

Tenedos eduardoi (Mello-Leitão, 1925)	X			X	1	4	7	12
Total					**2,785**	**4,094**	**7,744**	**14,626**

Among the 373 total species, 342 were represented by adult specimens and only 31 were represented by juveniles. Herein, 314 species were collected exclusively through the standardized survey (84.6% of the total species) with 287 represented by adults and only 29 represented by juveniles. The species represented only by juveniles were added to the database when it was clear that the spiders did not belong to any one of the other species already included. Almost all of the added species belonged to genera or even families not yet represented in the database.

A thorough analysis of the literature resulted in 17 papers containing records for 25 species and 37 specimens. Those records included specimens not only for the Park itself, but also to surrounding areas, as Jacarepaguá or only Pedra Branca. The database of Laboratório de Aracnologia, Museu Nacional/UFRJ, included 42 species/morphospecies and 83 specimens from the park and surrounding areas. The examination of the collection of the Laboratório de Diversidade de Aracnídeos/UFRJ revealed that 17 species and 26 specimens were from the same areas. The literature and collection records added up together 67 species/morphospecies and 134 specimens. Among the 12 species from the literature and that were not collected during the standardized survey, seven were labeled informing the Park itself or just “Pedra Branca”. Four species were cited only to a larger area that includes the Park (Jacarepaguá): *Teudis atrofasciatus*, *Xeropigo tridentiger*, *Peucetia flava*, *Peucetia rubrolineata* and one cited for Recreio dos Bandeirantes, an area nearby the Park: *Corinna demersa*. Moreover, among the eight species present only on collections, three were mentioned from the surroundings: *Actinosoma pentacanthum*, *Dendryphantes* sp. 01 and *Parasteatoda tepidariora*. The inclusion of those ten species in the list was made for the sake of completude and reflects our belief that they are probably present in the park area. They may be rare or inhabit areas not sampled by us.

Species Abundance

Regarding species abundance, the 22 most abundant species (6.2% of total richness), represented by at least 1% of the total collected specimens, added up to 8,513 specimens (58.7% of total abundance) (Fig. 3). On the other hand, 74 species are represented by only one specimen (singletons) and 37 by two specimens (doubletons). These “rare species” represent a sizable piece of richness (33%), but only a small part of total abundance (1.1%). The ten most abundant species in order are: *Mesabolivar luteus* (2,050 specimens); *Mesabolivar togatus* (647); *Micrathena sanctispiritus* (601); *Cryptachaea digitus* (579); *Chrysometa ludibunda* (545); *Patrera cita* (488); *Odo pulcher* (450); *Thwaitesia affinis* (386); *Carapoia* sp. n. 02 (335) and *Janula bicorniger* (324).

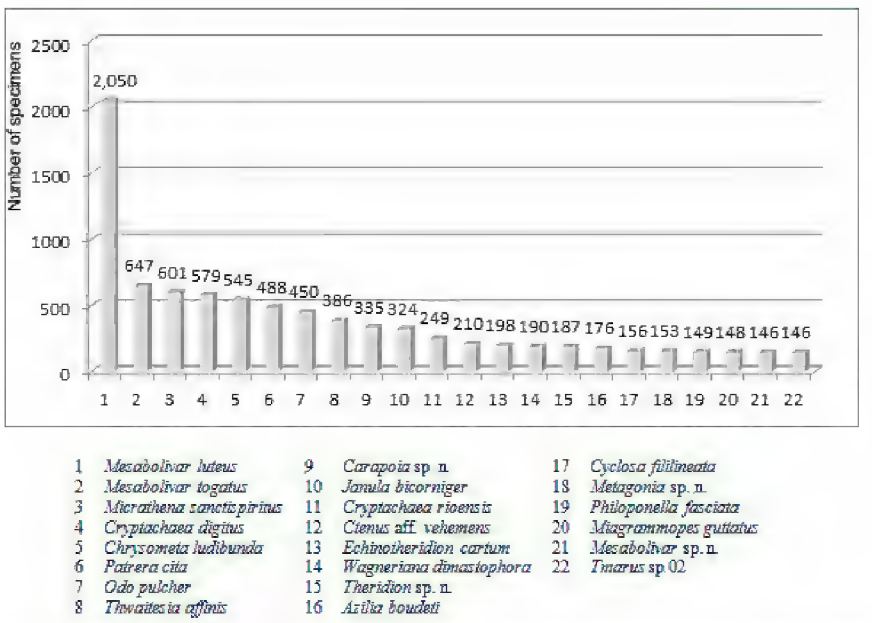

Figure 3.

Abundance of collected species with more than 1% of total abundance.Suppl. material 1

The difference in abundance between *Mesabolivar luteus* (2,050 specimens) and the second most abundant species, *Mesabolivar togatus* (647 specimens) is clear-cut, where both are dominant species in the local spider fauna. Apparently, according to our field observations on these very dominant species, they do not compete against each other, as *M. luteus* occupies higher places in the vegetation in comparison to *M. togatus*. It is also noteworthy that other three species among the 22 more abundant species are Pholcidae, *Carapoia* sp. n. 02, *Mesabolivar* sp. n. and *Metagonia* sp. n.

In relation to family richness and abundance, our results were in line with similar surveys on Atlantic Forest. Theridiidae is the richest family with 66 species (18.7%) in 27 genera. On the other hand, its abundance is the second highest, with 3,160 specimens (21.6%). As the second richest family, we observed Araneidae with 47 species (13.3%) in 21 genera. This family is the third most abundant (2,005 specimens). The third richest family was Salticidae with 45 species (12.8%), in 27 genera, and 640 specimens (only 4.4% of the total). Pholcidae was the most abundant family, with 3,810 specimens (26.3% of the total), but the fifth richest one, with 17 species (4.8%). The relatively high richness of Pholcidae in Pedra Branca State Park represents the highest number of species for the family in the world. The previous record was 15 species of Pholcidae in Reserva Ecológica de Guapiaçu, Cachoeiras de Macacu, also in Rio de Janeiro state, Brazil (Huber and Rheims 2011).

Richness estimates

To estimate the possible reach of the spider fauna, an accumulation curve was calculated using the most used estimators from literature by the software EstimateS Richness Estimator Program, Version 9.1 (Colwell 1999). Only data from the standardized surveys of the park were included in our analysis.

Different estimators indicate a species total ranging from a minimum of 388 (“Bootstrap”) to a maximum of 468 species (“Jackknife2”) in this specific situation (Table 2, Fig. 4). Bootstrap estimator does not use only rare species to estimate the total richness, but all the samples obtained during the survey. It is calculated by adding up the total richness to the sum of the inverse proportion of samples in which every species occur (Smith and van Belle 1984). On the other hand, Jackknife is a general statistical technique for reducing the bias of an estimator by removing subsets of the data and recalculating the estimator. Jackknife2 adds the total observed richness to a parameter calculated from the number of individuals and of rare species found only in one (uniques) or two samples (duplicates) in order to obtain the total species richness (Gotelli and Colwell 2010).

Table 2.

Results of non parametric estimators of richness, number of collected species, unicates and duplicates for the data obtained by standardized sampling in Pedra Branca State Park.

Species	353	**Chao1**	425.09
Uniques	78	**Chao 2**	429.81
Duplicates	39	**Jackknife1**	429.81
ACE	420.12	**Jackknife2**	468.71
ICE	419.08	**Bootstrap**	387.89

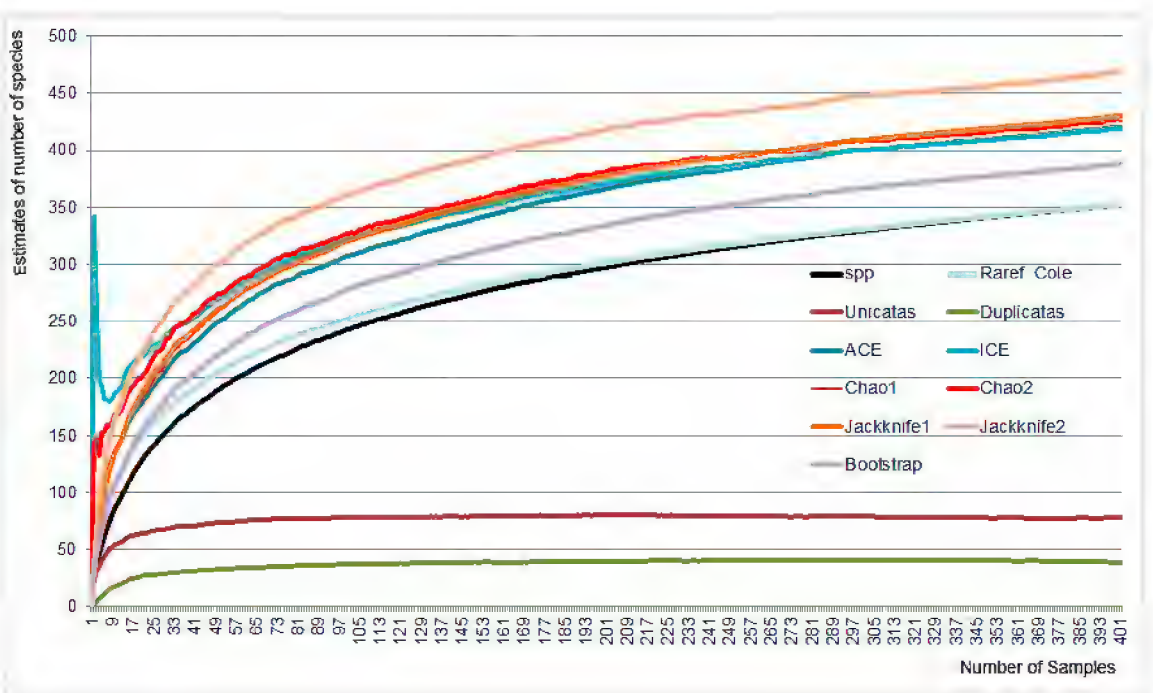

Figure 4.

Species accumulation curve for different estimators of diversity, calculated by the software EstimateS v9.1, based only in standardized sampling. X axis: number of samples. Y axis: estimates of number of species Suppl. material 2).

In the present work, the species accumulation curves still have not reached an asymptote, but the curves slopes are apparently beginning to decrease. This may indicate that the curves are converging to a plateau and to stabilization on the estimated number of species.

The effective number of species (353) is still lower than the lesser optimistic estimator ("Bootstrap"). Besides, the number of uniques reaches 78 and is exactly the double of the duplicates and the intersection between the two curves would only be reached by surveying the area during a few more years, which indicates the need for a higher collection effort.

Diversity patterns

The analysis of diversity patterns of the spider community in the study area includes the comparison of population parameters for each sampling station individually or by each Park core, Pau da Fome (S1 & S2) and Camorim (S3 & S4). The diversity indexes used were Shannon-Wiener (H'), equitability of Pielou (J) and dominance of Berger-Parker (d) (Table 3).

Table 3.

Diversity indexes of the spider community of Pedra Branca State Park.

Locality	Richness	Shannon (H')	Shannon Exp	Pielou (J)	Berger-Parker (d)
Pau Fome	**248**	**4.051**	**57.455**	**0.691**	**0.189**
Station 1	182	3.999	54.544	0.682	0.131
Station 2	199	3.784	43.992	0.645	0.243
Camorim	**291**	**4.411**	**82.352**	**0.752**	**0.091**
Station 3	216	3.960	52.457	0.675	0.158
Station 4	222	4.331	76.020	0.739	0.055

In relation to alpha-diversity, H' was higher for Camorim (4.411), with an effective number (Shannon Exponential) of approximately 82 species. On the other hand, for Pau da Fome, H' was 4.051, with Shannon Exp of around 57 species. Individually, station 4 ("Açude") presented the highest rate for H' (4.331), with Shannon Exp of 76 species, followed by station 1, with H' of 3.999. These numbers indicate that Camorim core (stations 3 and 4) is more diverse than Pau da Fome (stations 1 and 2).

The high H' for station 4 is coupled to the highest equitability (J = 0.739) and the lowest dominance of one species (d = 0.055). In contrast to the dominance of *Mesabolivar luteus* in stations 1, 2 and 3, the most abundant species in Station 4 is *Chrysometa ludibunda*, with 204 specimens, whereas the second one is *Mesabolivar togatus* with 196 specimens. Those results, allied to the highest abundance and richness, indicates that station 4 is the best preserved and has the most complex environment among all stations.

Species new records and distributions

According to the World Spider Catalog 2015, this survey also highlights some new distribution records for different areas: **Liocranidae** - new family distribution record for Brazil; **Tetragnathidae:** *Tetragnatha mandibulata* Walckenaer, 1841 - new species

distribution record for Americas; **Linyphiidae:** *Erigone autumnalis* Emerton, 1882 - new species distribution record for South America; **Mysmenidae:** *Maymena* sp. n. – new genus record for Brazil; **Salticidae:** *Encolpius guaraniticus* Galiano, 1968 – new species record for Brazil and new genus record for Southeastern region; and **Tetragnathidae**: *Leucauge pulcherrima* (Keyserling, 1864) and **Theridiidae:** *Dipoena cornuta* Chickering, 1943, *Dipoena bryantae* Chickering, 1943 - all new species records for Brazil.

Discussion and Conclusions

Our study uses standardized techniques alongside statistical tools to estimate the spider fauna in forested areas in Rio de Janeiro state. About Brazil as a whole, we can find studies documenting the fauna of spiders presenting a simple list of species (e. g. Buckup et al. 2010, Brescovit et al. 2011, Chavari et al. 2014, Melo et al. 2014, Nogueira et al. 2014), and others that consider statistical tools to analyze the dynamics of the fauna (e. g. Álvares et al. 2014, Indicatti et al. 2005, Candiani et al. 2005, Raizer et al. 2005, Nogueira et al. 2006).

In the state of Rio de Janeiro, the Laboratório de Diversidade de Aracnídeos is an active group working with spiders surveys in many different areas, like an ongoing work in the municipality of Macaé and other in the municipality of Mendes, which composed the monograph of Prado (2015). In the city of Rio de Janeiro, however, our knowledge is still very incipient, with information from Parque Municipal do Marapendi (Marapendi Municipal Park), which until now was the only area of the city entirely surveyed with records of 159 species (Baptista et al. 2015). Parque Nacional da Tijuca (Tijuca National Park) however, has already been partially surveyed as part of Rapid Ecological Survey during the elaboration of a new management plan for Tijuca Park. This study was included in the monograph of Silva-Moreira (2006), where 308 species of spiders are mentioned for Tijuca National Park. Also, before this survey at Pedra Branca State Park, in the city of Rio de Janeiro, there have never been any statistical treatments about the spider fauna diversity.

Furthermore, sampling efforts must be considered in each survey because the spider fauna recorded for Tijuca is the result of a Rapid Ecological Survey with only one expedition with standardized methods. However, this specific area has many sporadic records since the 19th century. Therefore, a beta diversity comparison between the fauna of Pedra Branca and Tijuca is still not feasible, but it is expected that they may share most of the spider species.

The survey in Pedra Branca overcame our initial expectations on species richness, especially considering that this Park is under high anthropic pressure. It was expected that areas under these conditions would only present a higher number of species of broad distribution, which may allow them to survive the human influence and to withstand a higher variation in environment factors. The remarkable richness recorded for this urban forest, even higher than in Tijuca, may be related to its location at the western portion of the city of Rio de Janeiro, an area where human occupation started later. Another reason

may be the predominance of steep hillside areas, which makes it difficult to access protected areas of the park.

Moreover, the little number of cosmopolitan and pantropical species and the large number of Brazilian species, especially the ones restricted to the Southeastern region, may indicate that the area of Pedra Branca State Park is still well preserved. However, the low comparative data from other areas hinders any inference on the subject at the present moment. So, we conclude this work acknowledging that even areas with high anthropic pressure can provide important information in order to ensure the protection of what remains of this historically vast area.

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Author contributions

PSC, RLCB and APG conceived and designed the experiments. PSC and RLCB collected, sorted, identified all specimens, analyzed the results and drafted the manuscript. APG revised the literature and improved the manuscript with important contributions. All authors read and approved the final manuscript.

References

- Agnarsson I, Coddington JA, Kuntner M (2013) Systematics Progress in the study of spider diversity and evolution. In: Penney D (Ed.) Spider Research in the 21st Century. 1, 1. The University of Manchester, Manchester, 53 pp. [In English]. URL: http://ezlab.zrc-sazu.si/uploads/2014/06/Agnarssonetal2013_SpiderSystematics_21stCentury.pdf [ISBN 978-0-9574530-1-2].
- Álvares ESS, Machado EO, Azevedo CS, De-Maria M (2014) Composition of the spider assemblage in an urban forest reserve in southeastern Brazil and evaluation of a two sampling method protocols of species richness estimates. Revista Ibérica de Aracnologia 10: 185. URL: http://www.researchgate.net/publication/237563702_Composition_of_the_spider_assemblage_in_an_urban_forest_reserve_in_southeastern_Brazil_and_evaluation_of_two_sampling_method_protocols_of_species_richness_estimates

- Andersen AN (1990) The use of ant communities to evaluate change in Australian terrestrial ecosystems, a review and a recipe. Proceedings of the Ecological Society of Australia 16: 347-357.
- Baptista RLC, Queiroz A, Castro DT, Hoffmann A, Castanheira PS, Quintarelli F (2015) Araneofauna (Arthropoda: Arachnida: Araneae) do Parque Natural Municipal de Marapendi, Rio de Janeiro, Brasil, com Notas Sobre as Espécies Fluminenses. In: Pontes JAL (Ed.) Biodiversidade Carioca: Segredos Revelados. 1. Technical Books, Rio de Janeiro, 23 pp. [In Portuguese]. [ISBN 978-85-61368-48-7].
- Brescovit AD (1999) Revisão das aranhas do gênero *Jessica* Brescovit (Araneae, Anyphaenidae, Anyphaeninae). Revista Brasileira de Entomologia 43: 249-269. [In Portuguese].
- Brescovit AD, Oliveira U, Santos AJ (2011) Spiders (Araneae, Arachnida) from São Paulo State, Brazil: diversity, sampling efforts, and state-of-art. Biota Neotropica 11 (1): 1-31. URL: http://www.biotaneotropica.org.br/v11n1a/en/abstract?inventory+bn0381101a
- Brown KS (1997) Diversity, disturbance, and sustainable use of Neotropical forests: insects as indicators for conservation monitoring. Journal of Insect Conservation 1: 25-42.
- Buckup EH, Marques MAL, Rodrigues ENL, Ott R (2010) Lista das espécies de aranhas (Arachnida, Araneae) do estado do Rio Grande do Sul, Brasil. Iheringia Série Zoologia 100 (4): 483-518. [In Portuguese]. DOI: 10.1590/S0073-47212010000400021
- Candiani DF, Indicatti RP, D. BA (2005) Composição e Diversidade da Araneofauna (Araneae) de Serapilheira em três florestas urbanas na cidade de São Paulo, São Paulo, Brasil. Biota Neotropica 5 (1): 1-13. [In Portuguese]. URL: http://www.biotaneotropica.org.br/v5n1a/en/fullpaper?bn008051a2005+pt
- Cardoso P, Scharff N, Gaspar C, Henriques SS, Carvalho R, Castro PH, Schmidt JB, Silva I, Szüts T, Castro A, Crespo LC (2008) Rapid biodiversity assessment of spiders (Araneae) using semi-quantitative sampling: a case study in a Mediterranean forest. Insect Conservation and Diversity 1 (2): 71-84. DOI: 10.1111/j.1752-4598.2007.00008.x
- Chavari J, Cipola N, Brescovit A (2014) Records of Spiders (Arachnida: Araneae) of the Parque Estadual Mata São Francisco, Paraná, Brazil. Check List 10 (6): 1435-1444. DOI: 10.15560/10.6.1435
- Coddington JA, Griswold CE, Silva D, Peñaranda E, Larcher SF (1991) Designing and testing sampling protocols to estimate biodiversity in tropical ecosystems. In: Dudley EC (Ed.) The Unity of Evolutionary Biology. 2. Proceedings of the Fourth International Congress of Systematic and Evolutionary Biology, Portland, 1048 pp.
- Colwell RK (1999) EstimateS: Statistical Estimation of Species Richness and Shared Species from Samples (Software and User's Guide). 8.2. URL: http://viceroy.eeb.uconn.edu/estimates
- Coura PHF, Sousa GM, Fernandes MC (2009) Mapeamento Geoecológico da Susceptibilidade à Ocorrência de incêndios no Maciço da Pedra Branca, Município do Rio de Janeiro. Anuário do Instituto de Geociências 32 (2): 14-25. [In Portuguese].
- Ferrier S, Powell GVN, Richardson KS, Manion G, Overton JM, Allnutt TF, Cameron SE, Mantle K, Burgess ND, Faith DP (2004) Mapping More of Terrestrial Biodiversity for Global Conservation Assessment. Bioscience 54: 1101-1109. DOI: 10.1641/0006-3568(2004)054[1101:mmotbf]2.0.co;2

- Fisher M (2000) Species loss after habitat fragmentation. Trends in Ecology & Evolution 15: 396. DOI: 10.1016/S0169-5347(00)01977-7
- Fundação SOS Mata Atlântica / Instituto Nacional de Pesquisas Espaciais (2011) Atlas dos Remanescentes Florestais da Mata Atlântica. Período 2008-2010. Relatório Parcial. http://mapas.sosma.org.br/dados. Accession date: 2014 7 25.
- Gotelli NJ, Colwell RK (2010) Estimating Species Richness. In: Magurran AE, McGill BJ (Eds) Biological Diversity: Frontiers in Measurement and Assessment. 1, 1. Oxford University Press, Oxford, 345 pp. DOI: 10.1016/j.baae.2011.07.002
- Huber BA, Rheims CA (2011) Diversity and endemism of pholcid spiders in Brazil's Atlantic Forest, with descriptions of four new species of the Atlantic Forest endemic genus *Tupigea* (Araneae: Pholcidae). Journal of Natural History 45 (5): 275-301.
- ICMBIO (2008) Plano de Manejo do Parque Nacional da Tijuca. 1. Ministério do Meio Ambiente, Brasília, 312 pp. [In Portuguese].
- Indicatti RP, Candiani DF, Brescovit AD, Japyassú HF (2005) Diversidade de aranhas (Arachnida, Araneae) de solo na Bacia do Reservatório do Guarapiranga, São Paulo, São Paulo, Brasil. Biota Neotropica 5 (1): 1-12. [In Portuguese]. URL: http://www.biotaneotropica.org.br/v5n1a/en/fullpaper?bn011051a2005+pt
- Melo T, Peres M, Chavari J, Brescovit A, Delabie J (2014) Ants (Formicidae) and Spiders (Araneae) listed from the Metropolitan Region of Salvador, Brazil. Check List 10 (2): 355-365. DOI: 10.15560/10.2.355
- MMA: Ministério do Meio Ambiente (2012) Bioma da Mata Atlântica. http://www.mma.gov.br/sitio/index.php?ido=ascom.noticiaMMA&idEstrutura=8&codigo=6229. Accession date: 2014 5 29.
- Myers N, Mittermeier RA, Mittermeier CG, Fonseca GAB, Kent J (2000) Biodiversity hotspots for conservation priorities. Nature 403: 853-858.
- Nogueira A, Venticinque E, Brescovit A, Lo-Man-Hung N, Candiani D (2014) List of species of spiders (Arachnida, Araneae) from the Pico da Neblina, state of Amazonas, Brazil. Check List 10 (5): 1044-1060. DOI: 10.15560/10.5.1044
- Nogueira AA, Pinto-da-Rocha R, Brescovit AD (2006) Comunidade de aranhas orbitelas (Araneae, Arachnida) na região da Reserva Florestal do Morro Grande, Cotia, São Paulo, Brasil. Biota Neotropica 6 (2): 1-24. [In Portuguese].
- Nyffeler M, Benz G (1987) Spiders in natural pest control: A review. Journal of Applied Entomology 104: 190-197. DOI: 10.1111/j.1439-0418.1987.tb00992.x
- Prado AWP (2015) Inventário da Araneofauna de Áreas Florestadas do Município de Mendes (Rio de Janeiro, Brasil). Universidade do Brasil/UFRJ, Rio de Janeiro, 85 pp. [In Portuguese].
- Quintarelli FM (2014) Aranhas (Arachnida: Araneae) do Estado do Rio de Janeiro. Universidade do Brasil (UFRJ), Rio de Janeiro, 124 pp. [In Portuguese].
- Raizer J, Japyassú HF, Indicatti RP, Brescovit AD (2005) Comunidade de Aranhas (Arachnida, Araneae) do Pantanal Norte (Mato Grosso, Brasil) e sua Similaridade com a Araneofauna Amazônica. Biota Neotropica 5: 1-16. [In Portuguese]. URL: http://www.biotaneotropica.org.br/v5n1a/en/fullpaper?bn009051a2005+pt
- Riechert SE, Lockley TC (1984) Spiders as biological control agents. Annual Review of Entomology 29: 299-320.
- Santos SB, Mayhé-Nunes AJ, Brown G, Costa JM, Lorenzon NCA, Salgado NC, Baptista RLC, Monteiro RF (2009) Invertebrados Terrestres. In: Bergallo HG, Rocha

CEM (Eds) Estratégias de Conservação da Biodiversidade da Mata Atlântica do Rio de Janeiro. UERJ, Rio de Janeiro, 25 pp. [In Portuguese].

- Scharff N, Coddington JA, Griswold CE, Hormiga G, Bjørn PP (2003) When to quit? Estimating spider species richness in a northern European deciduous forest. Journal of Arachnology 31: 246-273. DOI: 10.1636/0161-8202(2003)031[0246:wtqess]2.0.co;2
- Schowalter TD (1995) Canopy arthropod communities in relation to forest age and alternative harvest practices in western Oregon. Forest Ecology and Management 78: 115-125. DOI: 10.1016/0378-1127(95)03592-4
- Silva-Moreira T (2006) Levantamento da Araneofauna (Arachnida: Araneae) do Parque Nacional da Tijuca. Universidade do Brasil (UFRJ), Rio de Janeiro, 54 pp. [In Portuguese].
- Smith EP, van Belle G (1984) Nonparametric estimation of species richness. Biometrics 40: 119-129.
- Soerensen LL, Coddington JA, Scharff NJ (2002) Inventorying and stimating subcanopy spider diversity using semiquantitative sampling methods in an Afromontane forest. Environmental Entomology 31 (2): 319-330.
- Toti DS, Coyle FA, Miller JA (2000) A structured inventory of Appalachian grass bald and heath bald spider assemblages and a test of species richness estimator performance. Journal of Arachnology 28: 329-345. DOI: 10.1636/0161-8202(2000)028[0329:asioag]2.0.co;2
- World Spider Catalog (2015) Natural History Museum Bern, version 15.5. http://wsc.nmbe.ch. Accession date: 2015 5 30.
- Young OP, Edwards ,B (1990) Spiders in United States field crops and their potential effect on crop pests. Journal of Arachnology 18: 1-27.

Supplementary materials

Suppl. material 1: Most Abundant Species at Pedra Branca State Park

Authors: Castanheira, Pérez-González & Baptista
Data type: Statistical
Brief description: This is a comparison summary of the most abundant species at Pedra Branca State Park. This data was obtained from Table 1.
Filename: Most abundant species.xlsx - Download file (12.51 kb)

Suppl. material 2: Estimates

Authors: Castanheira, Pérez-González & Baptista
Data type: Statistical
Brief description: This is the raw data that made possible the construction of the graphic that shows the estimates of species.
Filename: Estimates.xlsx - Download file (1.08 MB)